STANDARD OPERATING PROCEDURE

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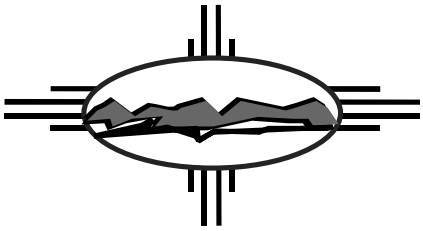
Monitoring Well and RFI Borehole Abandonment	**ER-SOP-5.03**	**1**	**06/01/99**



ER PROJECT

APPROVALS FOR USE

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LOS ALAMOS NATIONAL LABORATORY

Monitoring Well and RFI Borehole Abandonment

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Monitoring Well and RFI Borehole Abandonment

NOTE: Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled document electronic file. However, it is their responsibility to ensure that they are trained on and utilizing the current version of this procedure. The procedure author may be contacted if text is unclear.

1.0 PURPOSE

This Standard Operating Procedure (SOP) states the responsibilities and provides instructions for acceptable and consistent monitoring well and RCRA (Resource Conservation and Recovery Act) facility investigation (RFI) borehole abandonment at the Los Alamos National Laboratory (Laboratory) ER Project.

2.0 TRAINING

2.1 All users of this SOP are trained by self-study, and the training is documented in accordance with QP-2.2.

2.2 The **Field Team Leader** (FTL) will monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments in accordance with QP-2.2.

3.0 DEFINITIONS

3.1 *Abandonment* — The plugging of a well or borehole in such a manner as to preclude migration of surface runoff or ground water along the length of the well.

3.2 *Annular seal* — The material, usually cement grout or bentonite, placed in the space between the borehole wall and the well casing for zone isolation, especially used to prevent surface contamination from entering the borehole.

3.3 *Annular space or annulus* — The space between the borehole wall and the well casing, or the space between a casing pipe and a liner pipe.

3.4 *Bentonite/Bentonite annular seal* — A hydrous aluminum silicate in slurry, powder, granular, or pellet form that, when hydrated, provides an impervious seal between the well casing and the borehole wall. Bentonite may also be used in a 2% to 5% mixture with Portland Type I or II cement to form a pumpable grout seal that expands as the material hardens.

3.5 *Filter pack* — Sand, gravel, or glass beads that are uniform, clean, and well rounded that are placed in the annulus of the well, between the borehole wall

and the well intake in order to prevent foreign material from entering through the well intake and to stabilize the formation.

3.6 *Grout* — Cement or bentonite mixtures used in sealing boreholes and wells and for zone isolation. Only Portland Type I or II cement is approved for use at investigative sites.

3.7 *Monitoring well* — Any well or borehole constructed for the purpose of monitoring fluctuations in groundwater levels, quality of groundwater, or the concentration of contaminants in the vadose zone or groundwater.

3.8 *RFI borehole* — A borehole whose purpose is the immediate or short-term determination of contamination conditions at a site, or a borehole used in a corrective action or remediation of a site.

3.9 *Site-Specific Health and Safety Plan (SSHASP)*—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

3.10 *Tremie pipe* — A small-diameter pipe used to carry sand pack, bentonite, or grouting materials to the bottom of the borehole. Materials are pumped under pressure or poured to the hole bottom through the pipe. The pipe is retracted as the annulus is filled.

3.11 *Well casing* — A solid piece of pipe, typically steel or polyvinyl chloride (PVC) plastic, used to keep a well open in either unconsolidated materials or unstable rock and as a means to contain zone-isolation materials such as cement grout or bentonite.

3.12 *Well screen* — Perforated wire-wrapped casing that allows fluids, but not solid material, to enter the well.

4.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

4.1 A properly abandoned monitoring well or borehole ensures that no surface water or contamination threatens the vadose or water-bearing zone in which the well lies. Contamination of other ground waters and zone-to-zone intermixing can also be prevented with proper abandonment.

4.2 Refer to the site-specific documents (Drilling Package and/or Borehole/Well Construction Field Data Log) for details of well or borehole construction at a given site.

5.0 EQUIPMENT

The following equipment may be needed to properly execute the instructions in this SOP:

- a drill rig or wireline rig and accompanying equipment,
- a casing perforator and cut-off tool,
- grout and/or cement,
- a tremie pipe,
- a grout pump with mechanical mixing ability,
- bentonite, and/or
- any additional supplies listed in associated procedures and equipment specified in associated SOPs and the SSHASP.

6.0 PROCEDURE

Note: Deviations from SOPs are made in accordance with QP-4.2.

6.1 Monitoring Wells

General requirements for abandoning monitoring wells are listed below.

6.1.1 Preliminary Work

6.1.1.1 A monitoring well will be investigated before it is destroyed, or abandoned to determine its condition and details of its construction. Construction details are found in the Drilling Package or Borehole/Well Construction Field Data Log. The well will be sounded (its depth measured with a weighted line) immediately before it is destroyed to make sure that it contains no obstructions that could interfere with filling and sealing.

6.1.1.2 The Focus Area Project Leader will be notified as soon as possible if pollutants or contaminants are known or suspected to be present in a well to be destroyed. Well-abandonment operations may then proceed only at the approval of the Focus Area Project Leader. Review ER-SOP-1.06 to determine the requirements for proper disposal of all materials removed from a well to be destroyed.

6.1.2 Sealing Conditions

The following minimum sealing conditions requirements will be met:

6.1.2.1 Where possible and practical, the monitoring well can be destroyed by removing all material within the original borehole including the well casing, filter pack, and annular seal. Material in the borehole may be removed by means of over-reaming (with a hollow-stem auger). Review ER-SOP-1.06 to determine the requirements for disposal of removed materials. The hole can then be completely filled with grouting material or cuttings as specified in Section 6.5 of this procedure.

6.1.2.2 Sealing material should be pumped under pressure to ensure that the monitoring well is properly filled and sealed.

6.1.2.3 If the casing, filter pack, and annular seal materials cannot or should not be removed (where good surface seal has been placed), they may be left in place. The casing left in place may require perforation or puncturing to allow proper placement of sealing materials. This sealing material should be pumped under pressure to ensure its proper distribution.

6.1.2.4 Where the casing is left in the hole, the casing may be cut at the surface.

6.1.2.5 The monitoring well should be filled to surface with cement grout, or within 10 ft of the surface with expanding bentonite grout. After the placement of the bentonite grout (if used) the remaining portion of the well should then be sealed with a Portland Type I or Type II cement with 2% to 5% bentonite as specified in Section 6.5 of this procedure.

6.2 RFI Boreholes

General requirements for abandoning RFI boreholes are listed below:

6.2.1 Preliminary Work

The borehole will be inspected immediately before filling and sealing operations. All obstructions that could interfere with filling and sealing operations will be removed before filling and sealing. All waste generated from borehole and well abandonment will be handled in accordance with ER-SOP-1.06.

6.2.2 Sealing Conditions

RFI boreholes can be completely filled with grouting material and/or cuttings as specified in Section 6.5 from bottom to top of the borehole.

6.3 Placement of Material

6.3.1 Placement Method

The monitoring well or RFI boring can be filled with appropriate sealing and fill material using a tremie pipe and proceeding to fill upward from the bottom of the well or boring. Sealing material may be placed by free fall only where the interval to be sealed is dry and no more than 30 ft in depth.

6.3.2 Timing of Placement

Place the sealing material in one continuous operation (or "pour") from the bottom to the top of the well or boring, unless conditions in the well or boring dictate that sealing operations be conducted in a staged manner.

6.3.3 Groundwater Flow

If subsurface pressure produces a flow of groundwater into a well or boring that is significant, use special care to restrict the flow while placing sealing and fill material.

6.3.4 Verification

Verify that the volume of sealing and fill material placed during abandonment operations equals or exceeds the volume to be filled and sealed. This is to help determine whether the well or boring has been properly destroyed and that no jamming or bridging of the fill or sealing material has occurred.

6.4 Options

6.4.1 Monitoring Wells and RFI Boreholes in Urban Areas and Active Technical Areas

6.4.1.1 The following options may be exercised for destroying monitoring wells and RFI boreholes in urban areas and near active technical areas.

- The upper surface of the sealing material may end at a depth of 5 ft below ground surface.
- If the well casing was not extracted during abandonment and sealing operations, a hole can be excavated around the well casing to a depth of 5 ft below ground surface

after sealing operations have been completed and the sealing material has adequately set and cured.

- The exposed well casing may then be removed by cutting the casing at the bottom of the excavation.
- The excavation will be back-filled and compacted with clean, native soil or other suitable material.

6.4.1.2 Temporary Cover

Whenever work is interrupted by such events as overnight shutdown, poor weather, or other delays, the monitoring well or borehole opening and any associated excavations will be covered at the surface. This is to ensure public safety and to prevent the entry of foreign material, water, pollutants, and contaminants. The cover will be held in place or weighted down in such a manner that it cannot be easily removed, except by equipment or tools.

6.5 Sealing Material

Sealing material used for abandoning monitoring wells or boreholes of a depth greater than 200 ft, shall consist of neat cement, with a 2% to 5% bentonite mixture, or high-solids bentonite grout.

In shallow dry RFI boreholes (nonmonitoring wells or boreholes where the casing has been removed) less than 200 ft in depth, cuttings can be replaced—if they can be placed (with certainty) without bridging. Dry bentonite may be added to the cuttings if desired. This operation can only be done where monitoring well or borehole depth and cuttings meet the conditions specified in ER-SOP-1.06.

6.5.1 Water

Water used to prepare sealing mixtures should generally be of drinking-water quality and shall be compatible with the type of sealing material used. It also should be free of petroleum and petroleum products and free of suspended matter. Water with a maximum of 2,000 mg/l of chloride and 1,500 mg/l of sulfate can be used for cement-based sealing mixtures. The quality of water to be used for sealing mixtures will be determined where unknown and the water source will be pre-approved by the Focus Area Project Leader and documented in the daily log.

6.5.2 Cement

Cement used in sealing mixtures will meet the requirements of American Society for Testing and Materials C150-92, Standard

Specification for Portland Cement, including the latest revisions thereof.

6.5.2.1 Types of Portland cement available under ASTM C150-92 for general construction are listed below.

- Type I; General purpose. Similar to American Petroleum Institute Class A.
- Type II; Moderate resistance to sulfate. Lower heat of hydration than Type I. This is similar to APE Class B.
- Type I/II; General purpose, mixture of Types I and II. Cement grout used for borehole sealing and hole abandonment will have a mixture of 2% to 5% bentonite powder added and be thoroughly mixed before pumping.
- Neat Cement; For Types I and II Portland cement, neat cement will be mixed at a ratio of one 94-lb sack of Portland cement to five to eight gallons of 'clean' water. Additional water may be required when bentonite is added.

6.5.2.2 Concrete is used for surface pad only.

6.5.2.3 Cement-based sealing materials should be mixed thoroughly by machine to provide uniformity and ensure that no 'lumps' exist before pumping. For abandonment where pumping is not required (30 ft or less), the grout may be mixed by hand.

6.5.2.4 Ratios of the bentonite used with cement-based sealing materials can be varied from 2% to 5%. Variations will be approved by the Focus Area Project Leader. The bentonite will be dry-mixed before hydration and additional water may be required.

6.5.2.5 Curing accelerators may be used for temporary and short-term surface casing seals. Typical accelerators are calcium chloride, sodium chloride, aluminum powder, or gypsum. The use of these materials requires approval by the Focus Area Project Leader.

6.5.3 Bentonite

6.5.3.1 Bentonite clay in 'gel' or slurry form has some of the advantages of cement-based sealing material. A disadvantage is that the clay can sometimes separate from the clay-water mixture. Although many types of clay mixtures are available, none has sealing properties comparable to bentonite clay. Bentonite expands significantly in volume

when hydrated. Only pure montmorilonite clay is an acceptable clay for bentonite annular seals.

6.5.3.2 Do not use bentonite clay seals where structural strength of the seal is required or where it will dry. Bentonite seals may have a tendency to dry, shrink, and crack where subsurface moisture levels are low. Bentonite clay seals can be adversely affected by subsurface chemical conditions, as can cement-based materials.

6.5.3.3 Do not use bentonite clay as a sealing material if roots from trees and other deep-rooted plants might invade and disrupt the seal and/or damage the well casing. Roots can grow into a bentonite seal in some surrounding soil and vegetation conditions.

6.5.3.4 Do not use bentonite-based sealing material, unless otherwise approved by the Focus Area Project Leader, for sealing intervals of fractured rock or sealing intervals of highly unstable, unconsolidated material that could collapse and displace the sealing material. Bentonite clay should not be used as a sealing material where flowing water might erode it.

6.5.3.5 Specifically prepare bentonite clay products used for sealing material. Used drilling mud cannot be used for sealing purposes.

6.5.3.6 Use only commercially prepared, powdered, granulated, pelletized, or chipped/crushed sodium montmorilonite clay bentonite for annular seals. The largest dimension of pellets or chips will be less than 1/5 the radial thickness of the annular space into which they are placed.

6.5.3.7 Thoroughly mix bentonite slurry mixtures with clean water before placement. Add a sufficient amount of water to bentonite to allow proper hydration. Depending on the bentonite sealing mixture used, add one gallon of water to about every 2 lbs of bentonite. Water added to bentonite for hydration will be of suitable quality, free of pollutants and contaminants, and pre-approved.

6.5.3.8 Bentonite slurry preparations normally require between 30 min. and 1 hr to adequately hydrate. Actual hydration time is a function of site conditions and the form of bentonite used. Finely divided forms of bentonite generally require less time for hydration, if properly mixed.

6.5.3.9 Dry bentonite pellets or chips may be placed directly into the annular space below water, where a short section of annular space is to be sealed. Care will be taken to prevent bridging during the placement of bentonite-seal material.

6.6 Reporting Requirements

Record all field work and comments on the Monitoring Well and Borehole Abandonment Information form (Attachment A). At a minimum, record the depth from surface to the bottom of the borehole, grout and bentonite/ cuttings depth and location, ground surface construction details, and actual composition of the grout and backfill. Attach original "as completed" drawings and/or Borehole/Well Completion Information form (from ER-SOP-5.01).

7.0 REFERENCES

The following documents have been cited within this procedure.

QP-2.2, Personnel Orientation and Training

QP-4.2, Standard Operating Procedure Development

QP-4.3, Records Management

ER-SOP-1.06, Management of Environmental Restoration Project Wastes

ER-SOP-5.01, Monitoring Well and RFI Borehole Construction

American Society for Testing and Materials, "Standard Specifications for Portland Cement," (ASTM, 1992), ASTM C150-92

8.0 RECORDS

The **FTL** is responsible for submitting the following records (processed in accordance with QP-4.3) to the Records Processing Facility.

8.1 Monitoring Well and Borehole Abandonment Information form (Attachment A)

9.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Monitoring Well and Borehole Abandonment Information (1 page)

Monitoring Well and Borehole Abandonment Information

Date/Time _____ Sheet ____ of ____

Technical Area _____ Focus Area _____ Field Unit _____

Borehole ID: _____ Well Type (monitoring, RFI borehole, etc.): _____

Site Work Plan _____

Grout Depth/Location:

Bentonite Depth/Location:

Other Fill Material Depth/Location:

Surface Construction:

Grout/Backfill Composition:

Additional Comments/Details:

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